ARTICLE X.

Additional Observations of the Magnetic Dip in the United States. By Elias Loomis, Professor of Mathematics and Natural Philosophy in Western Reserve College. Read October 14, 1839.

THE following observations were made with the same instrument, and the mode of observing adopted was the same as described in a former paper. In needle No. 1, I have continued to find the magnetic axis to coincide very nearly with the geometrical. The inclination has never exceeded a few minutes. In needle No. 2, on the contrary, this inclination has seldom been less than one degree, and, in a few instances, has exceeded two degrees. Yet, although the magnetic axis of this needle never coincides with the geometrical, it does not maintain a constant position with respect to it. If the reading of the needle is at one time too great, when its polarity is reversed, in the same position of the instrument and needle, the reading is invariably too small, showing that the magnetic pole has passed to the other side of the geometrical. In other words, the magnetic axis, instead of revolving 180° from a reversal of the poles, revolves only 175° or 178°. That this anomaly is not to be ascribed to the mode of magnetising employed is, I think, evident from the uniformity of the effect, and from the fact that in needle No. 1, though magnetised in the same way, nothing similar is observed. I can only ascribe it to some peculiarity in the material or temper of the needle. In the transportation of the instrument from place to place by public conveyances, the level was, in several instances, slightly deranged. This was always verified by reversal, previous to commencing the observations, and the level readjusted when necessary. It is believed that the instrument has sustained no injury from transportation, and that it is susceptible of as great accuracy now as formerly. The observations made at Hudson,

October 7th, 1839, afford presumptive evidence of this.   In order to obviate all danger of mistake in reversing the poles, a small dot of ink was placed upon each needle, and the position of this mark, whether *up* or *down*, was always entered at the head of the observations.   The following observations are arranged in the order of their dates:—

Magnetic Dip at Hudson, Ohio, Latitude 41° 15′ *N.; Longitude* 5*h.* 26*m. W.*

Place of observation the same as formerly described.

Date.	Hour.	Needle.	No. Readings.	Dip.
1839, Aug. 16th,	7—9, A. M.	No. 1,	40	72° 54′.4
" " "	" "	No. 1, poles reversed,	40	42 .9
" " "	" "	Mean of No. 1,	80	48 .6
" " "	" "	No. 2,	40	22 .2
" " "	" "	No. 2, poles reversed,	40	69 .6
" " "	" "	Mean of No. 2,	80	45 .9
" " "	" "	Mean of two needles,	160	72 47 .3

The mean of the observations with the two needles is nearly the same, yet the observations with No. 2, in its two magnetic states, differs by 47′, indicating an inequality in the arms of the needle.   If the needle could always be magnetised with the same intensity, the effect of this inequality would be eliminated by reversing the poles; yet, as this condition is not easily fulfilled, it is better to make the arms of the needle of equal weight.   The heaviest end of No. 2 was therefore rubbed on a hone, and the observations repeated.

Date.	Hour.	Needle.	No. Readings.	Dip.
1839, Aug. 18th,	8—9, A. M.	No. 2,	40	72° 36′.8
" " "	" "	No. 2, poles reversed,	40	51 .9
" " "	" "	Mean of No. 2,	80	72 44 .4

Here the inequality is reduced to 15′.   The heavy end was again applied to the hone, and the following observations made:—

Date.	Hour.	Needle.	No. Readings.	Dip.
1839, Aug. 19th,	9—10, A. M.	No. 2,	40	72° 51′.9
" " "	" "	No. 2, poles reversed,	40	57 .7
" " "	" "	Mean of No. 2,	80	72 54 .8

The inequality is here reduced to 5′.8, and no farther change was made in the needle during the whole of the subsequent observations.   The mean of the

last 160 observations of No. 2 is 72° 49'.6, and *the mean of the* 320 *readings,* Aug. 16th—19th, is 72° 48'.4.

Magnetic Dip at Buffalo, New York, Latitude 42° 53' N.; Longitude 5h. 16m. W.

Place of observation a few rods east of the American House.

Date.	Hour.	Needle.	No. Readings.	Dip.
1839, Aug. 31st,	8—10, A. M.	No. 1,	40	74° 36'.3
" " "	" "	No. 1, poles reversed,	40	43 .1
" " "	" "	Mean of No. 1,	80	39 .7
" " "	" "	No. 2,	40	37 .4
" " "	" "	No. 2, poles reversed,	40	46 .2
" " "	" "	Mean of No. 2,	80	41 .8
" " "	" "	Mean of both needles,	160	74 40 .8

Magnetic Dip at Oswego, New York. Latitude 43° 26' N.; Longitude 5h. 6m. W.

Place of observation a few rods west of the village.

Date.	Hour.	Needle.	No. Readings.	Dip.
1839, Sept. 1st,	7½—9½, A. M.	No. 1,	40	75° 17'.3
" " "	" "	No. 1, poles reversed,	40	4 .8
" " "	" "	Mean of No. 1,	80	11 .1
" " "	" "	No. 2,	40	13 .2
" " "	" "	No. 2, poles reversed,	40	9 .7
" " "	" "	Mean of No. 2,	80	11 .5
" " "	" "	Mean of both needles,	160	75 11 .3

Magnetic Dip at Syracuse, New York. Latitude 43° 0' N.; Longitude 5h. 5m. W.

Place of observation a grove, a few rods north-east of the village.

Date.	Hour.	Needle.	No. Readings.	Dip.
1839, Sept. 2d,	8—10, A. M.	No. 1,	40	74° 47'.8
" " "	" "	No. 1, poles reversed,	40	51 .6
" " "	" "	Mean of No. 1,	80	49 .7
" " "	" "	No. 2,	40	50 .2
" " "	" "	No. 2, poles reversed,	40	54 .0
" " "	" "	Mean of No. 2,	80	52 .1
" " "	" "	Mean of both needles,	160	74 50 .9

Magnetic Dip at Utica, New York.   Latitude 43° 7' N.; Longitude 5h. 1m. W.

Place of observation a few rods north-east of the village.

Date.	Hour.	Needle.	No. Readings.	Dip.
1839, Sept. 3d,	5½—7½, A. M.	No. 1,	40	74° 54'.0
" " "	" "	No. 1, poles reversed,	40	52 .6
" " "	" "	Mean of No. 1,	80	53 .3
" " "	" "	No. 2,	40	59 .5
" " "	" "	No. 2, poles reversed,	40	62 .6
" " "	" "	Mean of No. 2,	80	61 .0
" " "	" "	Mean of both needles,	160	74 57 .2

Magnetic dip at Schenectady, New York.   Latitude 42° 48' N.; Longitude 4h. 56m. W.

Place of observation a few rods south of the village.

Date.	Hour.	Needle.	No. Readings.	Dip.
1839, Sept. 3d,	4½—6½, P. M.	No. 1,	40	74° 40'.7
" " "	" "	No. 1, poles reversed,	40	40 .9
" " "	" "	Mean of No. 1,	80	40 .8
" " "	" "	No. 2,	40	24 .6
" " "	" "	No. 2, poles reversed,	40	38 .1
" " "	" "	Mean of No. 2,	80	31 .3
" " "	" "	Mean of both needles,	160	74 36 .1

Magnetic Dip at Albany, New York.   Latitude 42° 39' N.; Longitude 4h. 55m. W.

Place of observation a few rods north-west of the capitol.

Date.	Hour.	Needle.	No. Readings.	Dip.
1839, Sept. 4th,	11, A.M.—1, P.M.	No. 1,	40	74° 55'.6
" " "	" "	No. 1, poles reversed,	40	45 .5
" " "	" "	Mean of No. 1,	80	50 .5
" " "	" "	No. 2,	40	53 .7
" " "	" "	No. 2, poles reversed,	40	50 .5
" " "	" "	Mean of No. 2,	80	52 .1
" " "	" "	Mean of both needles,	160	74 51 .3

Magnetic Dip at West Point, New York. Latitude 41° 25' N.; Longitude 4h. 56m. W.

Place of observation on the bank of the river, near the steam-boat landing.

Date.	Hour.	Needle.	No. Readings.	Dip.
1839, Sept. 5th,	3—5, P. M.	No. 1,	40	73° 28'.9
" " "	" "	No. 1, poles reversed,	40	27 .7
" " "	" "	Mean of No. 1,	80	28 .3
" " "	" "	No. 2,	40	22 .8
" " "	" "	No. 2, poles reversed,	40	30 .0
" " "	" "	Mean of No. 2,	80	26 .4
" " "	" "	Mean of both needles,	160	73 27 .4

Magnetic Dip at New York City. Latitude 40° 43' N.; Longitude 4h. 56m. W.

Place of observation the yard in front of Columbia College.

Date.	Hour.	Needle.	No. Readings.	Dip.
1839, Sept. 9th,	8—10½, A. M.	No. 1,	40	72° 54'.8
" " "	" "	No. 1, poles reversed,	40	47 .1
" " "	" "	Mean of No. 1,	80	50 .9
" " "	" "	No. 2,	40	47 .1
" " "	" "	No. 2, poles reversed,	40	59 .9
" " "	" "	Mean of No. 2,	80	53 .5
" " "	" "	Mean of both needles,	160	72 52 .2

Magnetic Dip at New Haven, Connecticut. Latitude 41° 18' N.; Longitude 4h. 52m. W.

Place of observation the burial ground.

Date.	Hour.	Needle.	No. Readings.	Dip.
1839, Sept. 11th,	7—9, A. M.	No. 1,	40	73° 24'.0
" " "	" "	No. 1, poles reversed,	40	34 .6
" " "	" "	Mean of No. 1,	80	29 .3
" " "	" "	No. 2,	40	14 .4
" " "	" "	No. 2, poles reversed,	40	33 .9
" " "	" "	Mean of No. 2,	80	24 .1
" " "	" "	Mean of both needles,	160	73 26 .7

VII.—2 B

Magnetic Dip at Hartford, Connecticut.   Latitude 41° 46' N.; Longitude 4h. 51m. W.

Place of observation a short distance north-west of the State House.

Date.	Hour.	Needle.	No. Readings.	Dip.
1839, Sept. 13th,	9½—11½, A. M.	No. 1,	40	73° 58'.2
" " "	" "	No. 1, poles reversed,	40	52 .4
" " "	" "	Mean of No. 1,	80	55 .3
" " "	" "	No. 2,	40	61 .0
" " "	" "	No. 2, poles reversed,	40	60 .8
" " "	" "	Mean of No. 2,	80	60 .9
" " "	" "	Mean of both needles,	160	73 58 .1

Magnetic Dip at Springfield, Massachusetts.   Latitude 42° 6' N.; Longitude 8h. 50m. W.

Place of observation a few rods east of Hampton Coffee House.

Date.	Hour.	Needle.	No. Readings.	Dip.
1839, Sept. 14th,	8—10, A. M.	No. 1,	40	74° 7'.6
" " "	" "	No. 1, poles reversed,	40	8 .1
" " "	" "	Mean of No. 1,	80	7 .8
" " "	" "	No. 2,	40	7 .0
" " "	" "	No. 2, poles reversed,	40	5 .0
" " "	" "	Mean of No. 2,	80	6 .0
" " "	" "	Mean of both needles,	160	74 6 .9

Magnetic Dip at Longmeadow, Massachusetts.   Latitude 42° 2' N.; Longitude 4h. 50m. W.

Place of observation a few rods west of the village church.

Date.	Hour.	Needle.	No. Readings.	Dip.
1839, Sept. 14th,	3¼—5, P.M.	No. 1,	40	74° 6'.4
" " "	" "	No. 1, poles reversed,	40	4 .0
" " "	" "	Mean of No. 1,	80	5 .2
" " "	" "	No. 2,	40	11 .7
" " "	" "	No. 2, poles reversed,	40	73 59 .0
" " "	" "	Mean of No. 2,	80	74 5 .4
" " "	" "	Mean of both needles,	160	74 5 .3

Magnetic Dip at Worcester, Massachusetts. Latitude 42° 16′ N.; Longitude 4h. 47m. W.

Place of observation a few rods west of Worcester House.

Date.	Hour.	Needle.	No. Readings.	Dip.
1839, Sept. 16th,	4—6, P. M.	No. 1,	40	74° 19′.6
" " "	" "	No. 1, poles reversed,	40	26 .0
" " "	" "	Mean of No. 1,	80	22 .8
" " "	" "	No. 2,	40	11 .1
" " "	" "	No. 2, poles reversed,	40	25 .5
" " "	" "	Mean of No. 2,	80	18 .3
" " "	" "	Mean of both needles,	160	74 20 .6

Magnetic Dip at Cambridge, Massachusetts. Latitude 42° 22′ N.; Longitude 4h. 44m. W.

Place of observation a few rods south-west of the colleges.

Date.	Hour.	Needle.	No. Readings.	Dip.
1839, Sept. 17th,	3—5, P. M.	No. 1,	40	74° 19′.2
" " "	" "	No. 1, poles reversed,	40	18 .9
" " "	" "	Mean of No. 1,	80	19 .1
" " "	" "	No. 2,	40	19 .4
" " "	" "	No. 2, poles reversed,	40	22 .7
" " "	" "	Mean of No. 2,	80	21 .0
" " "	" "	Mean of both needles,	160	74 20 .1

Magnetic Dip at Providence, Rhode Island. Latitude 41° 50′ N.; Longitude 4h. 46m. W.

Place of observation near the steam-boat landing.

Date.	Hour.	Needle.	No. Readings.	Dip.
1839, Sept. 19th,	11½, A.M.—1, P.M.	No. 1,	40	73° 57′.0
" " "	" "	No. 1, poles reversed,	40	60 .6
" " "	" "	Mean of No. 1,	80	58 .8
" " "	" "	No. 2,	40	62 .8
" " "	" "	No. 2, poles reversed,	40	57 .9
" " "	" "	Mean of No. 2,	80	60 .3
" " "	" "	Mean of both needles,	160	73 59 .6

Magnetic Dip at Princeton, New Jersey.   Latitude 40° 22′ N.; Longitude, 4h. 58m. W.

Place of observation an open field, one hundred rods south of the colleges.

Date.	Hour.	Needle.	No. Readings.	Dip.
1839, Sept. 21st,	10—12, A. M.	No. 1,	40	72° 47′.4
" " "	" "	No. 1, poles reversed,	40	47 .4
" " "	" "	Mean of No. 1,	80	47 .4
" " "	" "	No. 2,	40	52 .9
" " "	" "	No. 2, poles reversed,	40	40 .8
" " "	" "	Mean of No. 2,	80	46 .8
" " "	" "	Mean of both needles,	160	72 47 .1

Magnetic Dip at Philadelphia, Pennsylvania.   Latitude 39° 57′ N.; Longitude 5h. 1m. W.

Place of observation the yard in front of President Bache's house.

Date.	Hour.	Needle.	No. Readings.	Dip.
1839, Sept. 23d,	10½—12, M.	No. 1,	40	72° 8′.6
" " "	" "	No. 1, poles reversed,	40	11 .3
" " "	" "	Mean of No. 1,	80	10 .0
" " "	" "	No. 2,	40	71 58 .9
" " "	" "	No. 2, poles reversed,	40	72 9 .6
" " "	" "	Mean of No. 2,	80	4 .2
" " "	" "	Mean of both needles,	160	72 7 .1

Magnetic Dip at Baltimore, Maryland.   Latitude 39° 17′ N.; Longitude 5h. 7m. W.

Place of observation the grove north of Washington Monument.

Date.	Hour.	Needle.	No. Readings.	Dip.
1839, Sept. 25th,	7—8, A. M.	No. 1,	40	71° 54′.3
" " "	" "	No. 1, poles reversed,	40	46 .3
" " "	" "	Mean of No. 1,	80	71 50 .3

Magnetic Dip at Washington City.   Latitude 38° 53′ N.; Longitude 5h. 8m. W.

Place of observation the yard in front of the capitol.

Date.	Hour.	Needle.	No. Readings.	Dip.
1839, Sept. 25th,	3—5, P. M.	No. 1,	40	71° 20′.9
" " "	" "	No. 1, poles reversed,	40	14 .5
" " "	" "	Mean of No. 1,	80	17 .7
" " "	" "	No. 2,	40	26 .4
" " "	" "	No. 2, poles reversed,	40	23 .7
" " "	" "	Mean of No. 2,	80	25 .1
" " "	" "	Mean of both needles,	160	71 21 .4

Magnetic Dip at Pittsburgh, Pennsylvania.   Latitude 40° 32′ N.; Longitude 5h. 20m. W.

Place of observation an open yard on the opposite side of Alleghany river.

Date.	Hour.	Needle.	No. Readings.	Dip.
1839, Sept. 30th,	9—11, A. M.	No. 1,	40	72° 44′.5
" " "	" "	No. 1, poles reversed,	40	39 .3
" " "	" "	Mean of No. 1,	80	41 .9
" " "	" "	No. 2,	40	34 .3
" " "	" "	No. 2, poles reversed,	40	37 .6
" " "	" "	Mean of No. 2,	80	35 .9
" " "	" "	Mean of both needles,	160	72 38 .9

Magnetic Dip at Beaver, Pennsylvania.   Latitude 40° 44′ N.; Longitude 5h. 22m. W.

Place of observation on the bank of the Ohio, near Beaver bridge.

Date.	Hour.	Needle.	No. Readings.	Dip.
1839, Oct. 1st,	8¾—10¼, A. M.	No. 1,	40	72° 34′.9
" " "	" "	No. 1, poles reversed,	40	40 .6
" " "	" "	Mean of No. 1,	80	37 .8
" " "	" "	No. 2,	40	40 .0
" " "	" "	No. 2, poles reversed,	40	45 .6
" " "	" "	Mean of No. 2,	80	42 .8
" " "	" "	Mean of both needles,	160	72 40 .3

VII.—2 c

Magnetic Dip at Hudson, Ohio.   Latitude 41° 15′ *N.; Longitude* 5*h*. 26*m*. *W*.

Place of observation the same as formerly.

Date.	Hour.	Needle.	No. Readings.	Dip.
1839, Oct. 7th,	1—3, P. M.	No. 1,	40	72° 49′.1
" " "	" "	No. 1, poles reversed,	40	45 .0
" " "	" "	Mean of No. 1,	80	47 .0
" " "	" "	No. 2,	40	43 .8
" " "	" "	No. 2, poles reversed,	40	46 .0
" " "	" "	Mean of No. 2,	80	44 .9
" " "	" "	Mean of both needles,	160	72 45 .9

In comparing the preceding observations, some discordances will be perceived. The difference of the readings in the two magnetic states of the needles is, by no means, constant. When the marked end of needle No. 1 was a north pole, the average observed dip was 4′.4 greater than when it was a south pole, showing a small but real inequality in the weight of the arms. Correcting the differences for this constant effect, the remainders are quite anomalous, and are subject to no obvious law. Their mean value is a little less than four minutes, and the greatest amounts to ten minutes. These anomalies may be ascribed to various causes, such as errors of observation; erroneous entries of readings; influence of currents of air, which, although the observations were all made under a glass cover, are quite appreciable when the wind is fresh; dust and moisture, and, perhaps, loose ferruginous particles collecting upon the needle, and producing a temporary inequality in the weight of the arms: this source of error I always endeavoured to guard against by carefully wiping each needle before the observations, yet it is doubtful if, even with this precaution, its effect was wholly eliminated. Dust and moisture, adhering to the pivots of the needles and to the agate supports, might also have a sensible influence; and, finally, it is, perhaps, credible that there may have been an appreciable diurnal change in the dip during the interval of the observations. Similar remarks apply to the observations with needle No. 2 in its different magnetic states. The mean results of the two needles at a single locality usually differ somewhat; and in

one instance, at Schenectady, the difference amounts to 9'.5; yet, for the entire series of observations, the average excess of the results with one needle above those with the other is only the tenth part of a minute, showing that the differences in the partial results are accidental; and as these differences are not very large, it is believed that the preceding observations furnish a tolerable approximation to the true magnetic dip at the places designated.